

Valuing the Environment

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Why nonmarket valuation?

- If we can't measure the value of environmental harm in monetary terms, much of conventional economic theory of the environment (Pigouvian taxes, Coasian liability rules) can't be applied.
- Benefit-cost analysis of projects & programs.
- Natural resource damage assessment.

The two facets of economics

- Explaining/predicting people's behavior
- Measuring people's preferences

Why do economists study people's choices?

One reason is to understand people's *behavior*, whether past behavior (e.g., why did shippers switch from railroad to trucking after 1950?) or future behavior (e.g. will peak pricing would reduce rush-hour road congestion?).

Another reason is to understand people's *preferences* and to assess changes in their *welfare* (e.g., will peak pricing make rush-hour commuters better off?).

- The two objectives of modeling behavior and measuring preferences often go hand-in-hand. Effective policy analysis usually involves *both* predicting behavior *and* assessing welfare impacts.
- Nevertheless, they have generally received unequal emphasis among economists.
- Following the rise of positivism in late C19, there was a move to narrow the role of preferences in economics, ending by 1938 with the minimalist position that the only thing economists should care about is that preferences are consistent, ordinal, and quasi-concave.
- Since 1960s there has been a renewal of interest in preferences.

What is the ethical basis of value?

- Distinguish two alternative approaches
Deontological view: nature has value in its own right.
Anthropocentric view: nature has value only to the extent that (some) people value it.
- It is the latter view that justifies the use of economics when discussing the value of the environment. Economics is inherently anthropocentric in its focus: it deals with how and why people behave.

Meaning of Economic Value

- The formal definition of 'economic value' has a somewhat long and tortuous history; it was not well settled until the 1970s
- The practical issue of measurement played key role: it was not until the 1970s that a practical method valuing *market* commodities was worked out
- The extension to non-market valuation was by then almost immediate

Does price measure economic value?

- This is what most people think: if an item has a price of \$7, then that is its economic value.
- This means that only marketed commodities can have economic value. There can be no such thing as non-market valuation.
- Since Dupuit(1844) and Marshall (1879) we have known that the answer is NO. But it took until 1970s for this to become well accepted in economics.

Why valuation matters: the distinction between demand and supply

- Demand has to do with what something is worth to people.
- Supply has to do with what it costs them to obtain it.

These are two entirely different issues.

Valuation deals with the former.

Economists often feel more comfortable dealing with the latter.

The Paradox of Value

- “Only what is rare is valuable, and water, which is the best of all things ... is also the cheapest.” (Plato)
- Adam Smith: Diamond and water paradox

Distinction Between Price vs Value

- Both Plato and Smith were expressing a thought that had occurred to many over the ages, namely that the market price of an item does *not* always reflect its *true* value.
- Market price reflects the fluctuating circumstance of daily life, whether the vagaries of supply or demand, while the true value is something more basic, enduring, and stable.
- Just what this true value is has been seen differently at different times.

Definitions of True Value

- Intrinsic value

Plato True value is intrinsic to the ideal Form underlying the item.

Aristotle True value is intrinsic to the natural end the item serves; e.g., a shoe is for wearing.

St. Thomas Aquinas The true value of an item is determined by its “inner goodness”, an intrinsic quality stemming from its relation to the divine purpose.

Later scholastics: Intrinsic value stems from inherent usefulness and ability to please man according to rational criteria)

Italian humanists (Danzoni, 1588)

- True value reflects subjective human preference rather than objective human need: men seek happiness by satisfying their wants and desires; value reflects “wants of the mind, most of them proceeding from imagination”

Locke, Hume, Smith, Ricardo: true value of an item is its long run cost of production

Distinguish two meanings of “value”

- Value as an indication of relative ranking
e.g., a human life is more important (valuable) than the life of a horse; a horse is more valuable than a diamond ring.
- Value as a measure of tradeoff (value in exchange)
e.g., the value of X in terms of Y is how much Y one would be willing to exchange for X.

Modern Definition of Economic Value

- Dupuit (1844) The “maximum sacrifice expressed in money which each consumer would be willing to make in order to acquire an object” provides “the measure of the object’s utility.”
- Marshall (1879) The “economic measure” of a satisfaction is “that which a person would be just willing to pay for any satisfaction rather than go without it.”

MARSHALL

- Marshall independently formulated a similar argument, based on a mathematical analysis, but also involving a similar intuition about the role of diminishing marginal utility.
- The key to differentiating this from expenditure is the consumer's demand function, viewed as a behavioral relationship
- The empirical fact that a demand function generally slopes down proves that marginal willingness to pay varies with consumption.

The key fact

- If a man would be induced to buy one pound of tea at a price of 20 shillings, but would buy two pounds at a price of 14 shillings, this demonstrates that (i) the first pound of tea is worth at least 20 shillings to him, and (ii) the second pound is worth *less than 20 shillings but at least 14 shillings*.
- When the price is 14 shillings, for an expenditure of 28 shillings he obtains something that is worth to him at least 34 shillings (i.e. $20 + 14$); thus, he gains a surplus satisfaction of at least 6 shillings, which Marshall called “consumers’ rent” in 1879 and “consumer’s surplus” in 1898

- This is an argument from revealed preference, emphasizing that the inference about the consumer's willingness to pay for tea is a logical implication of his observed behavior in buying “of his own free choice” the second pound of tea at one price but not the other.

Calculation

- How does one calculate this economic measure of satisfaction?
- The answer is that the consumer's surplus can be measured as an area under the demand function (the “Marshallian triangle”).
- Consequently, if you know the demand function, you can estimate the consumer's surplus.

- Marshall noted that there were several technical conditions that had to be satisfied for this area to be a completely accurate measure of the consumer's surplus.
- However, he felt that, in practice, even if these conditions didn't hold exactly, the area under the demand curve should be a reasonable approximation.
- That was in the 1870s. By the end of his life, Marshall came to be less optimistic that the area was a valid or useful approximation.

Post-Marshall

- By the early 1900s, Marshall's analysis was had fallen out of favor.
- It was out of sync with the rise of interest in a more formal and mathematical style of analysis.
- It also seemed to be based on what were now regarded as simplistic and unscientific psychology of the mind.

- Marshall's consumer's surplus also was seen as unnecessary. As a by-product of the marginal revolution and the development of first-order conditions for utility maximization, the view developed that market price offered a satisfactory measure of welfare – it was both practical and objective.
- Given some quantity change for a marketed commodity, Δx_i , the economic value of this change should be measured as: $\Delta W = p_i \Delta x_i$.
- If there is no market price, then one should find a surrogate for p_i

Drawbacks of using market price to measure value

- Only works when there *is* a market price. Otherwise, ability to find a “surrogate” is questionable. Essentially limits valuation to market commodities.
- It understates benefit (since there is actually some consumer’s surplus on the infra-marginal units, which is being ignored).
- If market price also reflects production cost, using price to approximate benefit generates a zero *net* benefit.

Steps in the rehabilitation of consumer's surplus

- 1930s Hicks shows that Marshall's analysis, including consumer's surplus, can be expressed precisely in terms of ordinal utility using indifference map analysis.
- Henderson & Hicks elucidate four concepts: compensating/equivalent variation/surplus
- But
 - Indifference curves are unobservable, so Hicks' findings are of not practical value
 - Samuelson's influential 1946 condemnation of consumer's surplus

Why and when did the situation change?

- Theoretical developments in the 1960s led utility to be recoverable from demand functions, and thus made it measurable (up to an ordinal transformation).

Duality theory

Integrability theory

- Link between demand function (observable, behavioral relation) and preferences (utility function), something not directly observable.

Hurwicz and Uzawa [HU] (1971)

Integrability Theorem

- It was known that maximization of a quasiconcave utility function leads to 4 key properties of demand functions.
- HU proved the converse: if the demand function satisfies these properties (symmetry and negative semi-definiteness), there exists an underlying quasiconcave utility function.
- They used a constructive proof which showed operationally how to recover the indirect utility function. That also sufficed for welfare analysis.

- HU analysis first exploited by Willig (1973, 1976 a.b)
- Also exploited by Hanemann (1980) and Hausman (1981)
- Vartia (1983) proposed the use of numerical techniques to solve HU's system of partial differential equations. Hausman and Newey (1995) apply this to a non-parametrically estimated demand function.

In summary

- Economic value is defined in terms of a tradeoff. When an economist states that, for some individual, X has a value of 50 in terms of Y, this means no more, and no less, than that the individual would be willing to exchange X for 50 units of Y. Y is the numeraire in terms of which value is measured, This numeraire can be money but it could, for example, be some specific commodity
- The measure of value is what the item is worth to the individual, not what it costs. It is the demand function rather than the supply function that is the repository of value. In this sense, economic value is inherently subjective and contingent.

- All of the foregoing discussion applies to *market* valuation: valuing the welfare effects of a price change in a marketed commodity.
- However, the extension to non-market valuation was immediate. Maler (1974), who had learned duality theory at MIT in 1969, saw this connection.

INTANGIBLES

- When cost-benefit analysis arose in late 1940s, it was still believed that economic value was measured by market price. Therefore, anything that did not have a market price (e.g., human life and limb, outdoor recreation) could not be assigned an economic value. These were considered “intangibles.”
- In late 1950s, it was recognized that market surrogates for some of these items do exist, through which they can be valued – the rise of nonmarket valuation

Non-market valuation

- Non-market valuation measures in monetary terms the value people place on an item they may care for.

Non-market valuation, continued

- It emerged in 1960s as part of a general trend to broaden the scope of application of economics to public spending decisions and government investment (cost-benefit analysis), including education and health (the rise of the human capital approach), and following a long-standing interest in the US in the evaluation of federal water projects.
- The techniques used are a direct translation of those used for market valuation, and were developed immediately following the diffusion of duality theory around 1970.

Use and non-use value

- The notion underlying nonuse value is that some people would be willing to pay to preserve a wilderness area even if they knew that neither they nor their children would ever visit it because they obtain satisfaction from mere knowledge that it exists (Krutilla, 1967).
- Non-use value is the value people place on an item for motives unconnected with their own potential use of it.
- Non-use value cannot be measured by revealed preference approaches.
- Use value is private good; non-use value a public good.

Economic value

- The economic value of an item is not how much you do pay for an item. It is how much money you *would be willing to exchange* the item for.
- There are two ways to frame the exchange:
 - The most you would be **willing to pay** for the item if you had to, and if you could get it by paying. (WTP)
 - The minimum compensation you would be **willing to accept** to give the item up. (WTA)
- Economic value is not limited to market items: as a thought experiment, it can be applied to anything that you care for.

Non-market valuation

- Non-market valuation measures in monetary terms the value people place on an item they may care for.
- Obtain a monetary measure of the change in the person's welfare by using the change in the person's monetary income that she would consider equivalent to the item in question in terms the overall impact on her satisfaction.
- Monetary value is thus defined in terms of a tradeoff that the person would make, whether framed in terms of WTP or WTA.

Using tradeoffs to measure economic value

How does one measure value?

- Ask people directly (stated preference)
 - If you could bring about Y, but you would have to pay X to accomplish this, would you be willing to do this?
(Create a tradeoff)
- Revealed preference. Infer value from the choices people make: their behavior reveals their underlying preference. Applies for non-market goods that are complements to purchase of market goods (Infer a tradeoff)

The logic of measurement

- Economic value is defined in terms of a trade-off.
- The measurement of value therefore proceeds by identifying a tradeoff.
- In revealed preference, the researcher finds (or postulates) a natural circumstance where a tradeoff occurs.
- In stated preference, the researcher presents subjects with a trade-off.

Two main approaches to measurement of non-market value

- **Revealed preference:** from observations of demand behavior with respect to marketed goods, infer preferences that generated this behavior and measure WTP or WTA; applies for non-market goods that are complements to purchase of market goods
- **Stated preference:** present subjects with tradeoffs through a survey; from survey responses infer preferences and measure WTP or WTA; applies for any non-market good.

Revealed preference: the travel cost approach

- In June 1947, the directorate of the National Park Service (NPS) was interested in placing an economic value on the services provided by national parks. At that time, there were no entry fees at national parks, so they generated virtually no revenue, and NPS was looking for a way to justify its budget. The project was assigned to an economist in the Planning Division, and he conceived the idea of writing to ten distinguished experts to solicit their advice. Almost all of them responded negatively -- they advised that it was not possible to measure these values in monetary terms.

- The chief exception was Harold Hotelling, then a professor of mathematical statistics at the University of North Carolina. He replied that he was “convinced that it is possible to set up appropriate measures for evaluating, with a reasonable degree of accuracy, the service of national parks to the public”
- Hotelling recognized that the question was identical to that confronting Dupuit when he considered how to measure the economic value of a road. The solution was the same: the economic value of the road/park was given by its consumer's surplus, as measured by the area under people's demand curve to use it. The practical problem was to measure this demand curve.

- Although there was no entry fee for a national park, Hotelling pointed out that there were *other* expenditures, such as travel, equipment or lodging, which were as much a part of the cost of enjoying the park as an entry fee – they were not captured by the Park but they set a price on visiting the park.
- Moreover, this price would vary among potential visitors residing at different locations. If the price could be measured and correlated with frequency of visitation, one would obtain a demand function for visiting the park, from which its value would be measured by the Marshallian triangle.
- In this context, price is important not as a measure of value per se but rather as an ingredient in a trade-off.

Stated preference: contingent valuation

- This was first suggested by S. V. Ciriacy-Wantrup (1947), in the context of measuring the benefits from soil conservation practices, some of which were “collective, extra-market goods” e.g., reduced siltation of reservoirs or reduced impairment of scenic resources.
- He characterized the essential problem as being to obtain a demand curve for such goods, and suggested the following solution: "Individuals of a sample or of a social group as a whole may be asked how much money they are willing to pay for successive additional quantities of a collective extra-market good. The choices offered relate to quantities consumed by all members of a social group. If the group interrogated is only a sample ... the modal schedule of the sample is obtained, and each point on this schedule is then multiplied by the number of individuals in the whole social group being investigated." What was thus obtained could be taken as the analog of a market demand schedule for the collective good.

Application of non-market valuation

- 1957 First travel cost study published – measuring benefits of water based recreation in Sierra lakes, in connection with proposed California State Water Project.
- 1963 First CV study published – measuring benefits of forest recreation
- 1973 Principles & Guidelines for Water projects endorses travel cost and CV

Valuation Methods

- Revealed preference
 - Measure a behavioral relation, obtain estimate of value by recovering underlying utility function
 - “travel cost”
 - averting behavior
 - Measure marginal value at one point
 - Hedonic property value
 - Health production function
- Stated preference
 - Contingent valuation (valuing an object)
 - Choice experiments (valuing attributes separately)

Demand function approach

- Identify group of people and behavior of interest.
- Obtain data on their choice behavior
- Fit appropriate set of demand equations
- From estimated demand equations recover estimate of consumer's surplus
 - Exact measure, by recovering underlying utility function
 - Approximation

Stated Preference Approach

- Identify group of people and appropriate item for them to value
- Develop and administer a survey presenting them with a tradeoff
- Analyze survey results and estimate measure of value

Types of question format

- Open-ended
 - How much would you be willing to pay for X?
- Closed-ended
 - If the government went ahead with a program to bring about X it would cost you and your household an extra \$A in annual taxes. If this program were on the ballot in a referendum would you vote for or against it?

Issues

- Is the survey meaningful – were they taking it seriously and answering it thoughtfully?
- Were they telling the truth? Were they correctly predicting what they would do?
- Are the resulting preferences consistent with economic theory? Is embedding a problem?

Was the survey meaningful?

- Did the respondents understand the issue?
- Was it meaningful to them?
- Did they take it seriously?
- Were they thoughtful in their response?

Were they telling the truth?

- Why might a respondent say yes when the real answer is no?
- Because he doesn't take the survey seriously?
- Because he wants to impress the interviewer?
- Because he is behaving strategically?
- Because he is not sure?
- Because he might?

The difficulty of measurement

- Distinguish theory from practice.
- Much of economic discussion focuses on theory, and what can be done in theory.
- This is distinct from what can be measured in practice. The practical problems of measurement are less widely known and appreciated.